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THE COURSE IN NATURAL SCIENCE IN THE UNIVERSITY ELEMENTARY SCHOOL. I

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Introductory statement.—Natural-science instruction in one form or another is given throughout the University Elementary and High schools. In all the grades all pupils have elementary science. In the first year of the high school almost all pupils have general science, the only exceptions being those pupils who have two foreign languages in their first-year course. Following the first year of the high school the work in the special sciences is elective.

General aims.—The work aims to utilize, extend, and develop the pupils' interests; to arouse new interests; to establish a fund of concrete experiences which are experimented with and discussed sufficiently to make them intelligently usable; to develop the habit of recognizing the problems which nature presents, and of trying to discover the explanatory reasons which are involved in such problems; to present to the pupils the types of materials and types of thinking which are involved in some of the divisions of science, and to give an elementary understanding by means of which they may appreciate the significance of some of the contributions which science has made to human welfare; above all the work is designed to stimulate the pupils to use science in their thinking and constructive work and to lead them to a measure of independence as they develop in their powers of observation, discrimination, and interpretation.

General methods.—In method, throughout the University Elementary and High schools, considerations of science are constantly based upon concrete experiences recalled from out-of-school life

or set forth in schoolroom demonstrations or experiments. Science must be concrete, not abstract, in order to be real to young students. The situations in life which make science study most important are usually very real and very concrete. Concrete studies are likely to become dynamic; abstract studies are in danger of becoming static. As pupils advance through the grades into the high school the same method of work is continued, but the proportionate amount of concrete materials may be reduced, since the ability to recall and use previous experiences and the experiences of others is increased. In dealing with the materials upon which the course is based the pupils are directed to constructive work as far as possible in order that they may develop the ability to use their senses objectively as well as the ability to consider the principles involved in the work which is being done. Topics and materials of practical interest are constantly used, not primarily, however, for a utilitarian end, though it is hoped that some measure of ability to use information, thought, and methods may be developed. Such materials are used because practical matters in science elicit more active interest and independent thought. The things which appeal to the pupils as most worth their consideration are the ones which stimulate their minds most, consequently the ones which are most educative. The science of the school, home community, and city, and of the personal needs of the pupils, both individually and as groups, is the science material which is best calculated to give the greatest and most permanent values in education. It requires science of no less value to solve a practical problem of the home than to solve one of the laboratory. The problem of the laboratory may easily be made to associate itself with the home, community, or needs of the pupils, else the problem should be left aside and supplanted by the one which may develop such associations.

NATURAL-SCIENCE COURSE OF STUDY, THE UNIVERSITY
ELEMENTARY SCHOOL

Introductory statement of aims, organizing principles, and standards of attainment.—This course of study in natural science has been organized on the general principle that the interests of the pupil

are constantly changing, and that these interests are increasing from year to year. In the very young pupil these interests are immediate and not prolonged; they are confined to narrow limits, to a small circle surrounding his life, but as mental life develops more remote interests appeal to the pupil.

The work of the lower grades.—The study of nature in the grades serves to rationalize and organize the children's interest in the outdoor world and to awaken new fields of interest. It tends to develop keen observation and thoughtful inquiry. While at best each of these can be realized but imperfectly, yet even this attitude can result only where opportunity for initiative, personal observation, and independent conclusions is provided, so that the very aim of the work necessitates first-hand contacts and out-of-door collection of materials for classroom use.

A young child's interest in nature is less reflective than active and objective. What things are and what he can do with them are his dominant interests. This work therefore employs activities with nature material rather than formal discussions or analyses of such material. In order that the children's motive may be clearly directed to an objective end, the outline for these grades centers itself about given activities.

The interest in basic activities, such as care of pets, making of gardens, etc., is persistent and is carried through the kindergarten and the three succeeding grades. On the other hand it is most necessary that each year shall give varied and enriched material and accomplish specific results. To gain this, detailed suggestions of variation in each activity are made, and particular objects of study are given in each outline, as just what birds, flowers, trees, etc., shall be observed and identified and what pets shall be kept. It would be unfortunate were this division of material interpreted as meaning that materials which come to the grade through transient interest are neglected, or that observation is limited to any prescribed choice of subjects. The division of materials endeavors to sustain normal variety of experience and range of familiarity with nature material.

Repetition of seasonal changes and of pupils' experiences in order to organize the vast variety of material into some coherence

and unity, together with the recurring interests of childhood, make repeated experiences most valuable. To many of us there are memories of repeated seasonal experiences, such as going each spring to the place where the first hyacinths were found, or on the annual autumn quest for nuts, or to the neighboring mill whose machinery entranced us, which experiences by their very repetition gained a charm and meaning quite unique. There is a reminiscent thrill in these experiences which is quite disproportionate to their face value augurs certainly an intimate appeal which was effective in establishing vivid images, individual interests, emotional growth, and significant sense training. It is to insure such experiences for our city-bred children that repeated excursions to the same place occur in the different grades.

In the following outlines for the kindergarten and primary grades the purposes, problems, and materials group themselves about the central activities. This form of organization emphasizes the underlying principle that science knowledge grows out of and is essential to certain childlike activities. There are ten such centers of work chosen for the kindergarten and first grade, and these are repeated and added to in the other primary grades. To follow this plan and see the orderly succession of the work a comparison of each activity throughout these grades is suggested. For example, if viewed through the grades it shows (1) the variety of pets provided, (2) the succession of observations in metamorphosis of moths and butterflies, (3) the increased experience in the care of aquaria, (4) the different types of study of the soil, (5) study of water, evaporation, dew, etc.

The work of the upper grades.—In the upper grades the former interests are kept, but in addition there comes a more intensive interest, a desire to apply some of the knowledge gained to the home and community life and to industrial processes. The graduated course in science as a whole is designed to contribute to the different stages of interest and mental growth.

In the fourth grade a more intensive study of both plant and animal life is introduced because the pupil is more eager now to learn about habits, life-histories, and interrelationships than he was in preceding years. The sense of responsibility and ownership

develops more rapidly at this age; the garden work is planned to foster this through the care of individual plots and the living things in them. He is led to study living things more thoroughly than before, and this intensive study forms better habits of observation and thinking. He learns to prepare aquaria and cages, to care for animals, to make drawings of them. All this widens his vision, quickens his imagination, and aids him in getting acquainted with his environment.

Above the fourth grade the awakening interests of the pupil are best helped in science by a more intensive study of many questions and things of everyday experience. The pupil has reached a higher standard of attainment, as evidenced by his more mature mental processes and his tendencies to more purposeful action. This enables him to undertake experimentally problems which require more prolonged attention. Using his powers in these ways he becomes acquainted with a fund of knowledge about materials, forces, and activities. In the high school and college such knowledge will be classified as physics, chemistry, biology, hygiene, geography, etc., but in the grades such classification is unimportant.

The work of the fifth grade is based partly upon the garden work of preceding years, and carries farther a study of soils and the relation of soils to plant growth. This intensifies the soil study of the fourth-grade geography. Connected with this is an intensive study of one or several plants, such as corn, wheat, and cotton, in which the economic factors are emphasized; or a similar study of certain animals, such as horses, cattle, and sheep. Some of the science problems of this grade concern the processes of making butter, soap, and candles; a few deal with foods; while others treat of physical forces. Thus more interests are awakened or fostered, new habits are formed, and greater skill in manipulation is developed. Also the vision of world-occurrences is widened and a deeper understanding of environmental conditions results.

In the sixth grade a summary of the needs of plants and animals for successful living includes relationships and struggles for life which plants, animals, and man have. Growing out of this is the study of hygiene, both personal and civic. The pupil is able now

to appreciate the importance of his maintaining habits of good health. The wisdom of making laws for promoting good sanitation and the health of the community is also better understood.

To satisfy still further the growing inquisitiveness and eagerness to learn the "how" and "why" of things, the science topics outlined in the latter part of the sixth grade and all of the seventh grade include experimental work in magnetism, electricity, and other physical topics, along with the manifold applications of such work to the home and industrial life.

Investigation of simple problems by experimentation develops that initial scientific attitude of mind which makes the pupil eager to try out things in order to prove or to disprove them. Thus more careful habits of thinking are formed, as is shown by more accurate statements of facts. Increased facility in manipulation shows the formation of other good habits.

The science work endeavors whenever possible to make applications of facts and principles learned, and to correlate the work with other studies, such as geography, history, composition, wood-working, printing, and mathematics. Throughout the grades the written work or sketches of the lower grades and the notebooks of the upper grades correlate the natural science with composition. Also the classroom and library use of selected books in studies of animal life, plant life, garden-making, electrical experiments, and the physics and chemistry of the home correlates the natural science with reading, literature, and history. Likewise much of the construction work demands the use of mathematics.

KINDERGARTEN

OUTLINE OF MATERIALS AND ACTIVITIES

1. Care of pets

Canaries

Chickens

Rabbits

2. Collection of caterpillars and cocoons

Caterpillars which are brought in are observed making cocoons. Cecropia and polyphemus cocoons are collected and kept through the winter so that the children may observe the appearance of the moth in the spring.

3. Care of aquarium containing goldfish and tadpoles
4. Recognition of the birds most common to the neighborhood and some knowledge of their habits.

Sparrow

Robin

Blue Jay

Woodpecker

In this connection the migration and return of the birds is brought out through observation and discussion.

5. Indoor and outdoor gardens

The children plant bulbs in various ways in the fall. Crocus and tulip bulbs are planted out of doors; hyacinth, jonquil, and narcissus bulbs are planted in window boxes, in jars of pebbles, and in water. The plants in the room are cared for daily by the children. A vegetable and flower garden is prepared, planted, and cultivated by the children. Selection is made from the following: lettuce, radish, pumpkin, beet, nasturtium, bachelor's button, zinnia.

6. Field trips

The children are taken to a nearby park once in the fall to see the autumn foliage, to gather acorns, and to feed the squirrels. They make frequent visits to the school garden and nearby vacant lots to gather seeds and acorns. In the spring they are taken to Jackson Park to look for birds and to see the rose garden. A trip is made to Washington Park to see the colony of martins and the display of spring flowers at the park conservatory.

7. Through the various activities of the school day the children become acquainted with the following natural objects:

Trees	Weeds	Wild Flowers
Oak	Dandelion	Violet
Poplar	Milkweed	Jack-in-the-pulpit
Maple		Buttercup
Pussy willow		
Garden Flowers	Grains	Vegetables and Fruits
Aster	Corn	Tomato
Marigold	Wheat	Pumpkin
Sweet pea	Oats	Onion
Nasturtium		Beet
Fall chrysanthemum		Carrot
Jonquil		Potato
Narcissus		Pepper

Garden Flowers

Crocus
Hyacinth

Vegetables and Fruits

Orange
Apple
Grape
Banana
Peach
Pear
Plum

Animals

Cow
Horse
Pig
Sheep
Chicken
Turkey
Earthworm
Ladybug
Caterpillar

8. Some of the most striking seasonal changes are brought to the notice of the children, such as the effect of frost on vegetation, the early darkness of the winter afternoons, the longer days in springtime, and the gradual change in the appearance of the out of doors as spring advances.

GRADE I

OUTLINE OF MATERIALS AND ACTIVITIES

1. Care of pets

A pair of ringdoves. These have sometimes nested and reared young birds in the schoolroom.

2. Observation of cecropia moths
3. Care of an aquarium containing goldfish and tadpoles
4. Study of ways to attract birds to our garden
5. Recognition and study of the most common birds of adjacent parks and gardens: English sparrow, robin, blue jay, red-headed woodpecker, tanager, and grackle.
6. Making indoor and outdoor gardens. In the autumn the children plant snowdrops and crocuses in the grass and Chinese lily bulbs in the house. In the spring they plant flowers and vegetables in the outdoor garden, choosing from the following list: nasturtium, cosmos, zinnia, aster, lettuce, radish, gourd, and pumpkin.
7. Trips to Jackson Park and to neighboring gardens and vacant lots are taken to see trees and birds and to feed the squirrels and grackles.

In this and in each of the primary grades the children keep in mind the general route of the trip. Upon their return it is laid out simply on the floor, in the sand pan, or on horizontal paper, with actual directions indicated.

8. An earthworm cage is made by the group, so that they can watch earthworms actually at work. (For details see Hodge, *Nature Study and Life*, p. 424.)
9. An "Outdoor Book" is made by each child which consists of blueprints, pictures, and his own drawings of the wild flowers, trees, shrubs, and animal life which he learns to know. This furnishes legitimate pleasure and as a record of the children's definite knowledge serves as a working basis in the following year.

The everyday experiences make the following nature material familiar to this grade:

Trees and Shrubs	Weeds	Wild Flowers	Animals
Oak	Milkweed	Sunflower	Ant
Elm	Burdock	Wild aster	Earthworm
Willow	Dandelion	Goldenrod	June bug (larva and winged stages)
Lilac	Plantain	Hepatica	Grasshopper
Syringa	Sand bur	Violet	Cricket
		Trillium	Ladybug
			Goldfish
			Tadpole
			Bee

10. Laboratory

Preparation of lemonade, cocoa, grape juice, butter, pop corn, oatmeal, and wheat cakes.

GRADE II

Although the same centers of interest are used again in this grade, the work here involves more consecutive records, attempts to discover cause and effect in the more obvious relations, experimentation to answer some questions which arise in the various activities, and more definite mapping of regions visited to show relative location and so to build up an idea of the Chicago region. Four new activities are added in this grade; they are numbered 11, 12, 13, and 14 in the outline below. These continue through the third grade.

OUTLINE OF MATERIALS AND ACTIVITIES

1. Care of pets
 - Goldfish
 - A pair of rabbits
 - Canaries
2. Observation of silkworm and polyphemus moths
 - Records of the life-cycles of these are made.
3. The aquarium started in the first grade is taken into the second grade, a Japanese goldfish and some snails are added, and the problem of making a balanced aquarium is undertaken. In the spring a trip is made to the swamp to gather such common material as water boatmen, whirling beetles, frogs' eggs, and dragon-fly larvae.
4. The second grade attempts to make our garden an attractive spot for birds. This involves a study of certain birds of the vicinity and their needs, and an effort to meet these needs.
5. Recognition and study of the following birds: bluebird, Baltimore oriole, summer warbler, American goldfinch, black and white warbler, sapsucker, brown thrasher, chewink, junco, red-winged blackbird, sandpiper, and kingfisher.
6. Making an indoor and outdoor garden

The second-grade children harvest in the fall the crop which they as first-grade children planted the previous spring. They plant snowdrops, crocuses, and scillas in the grass and lilies of the valley in beds. Indoors they plant in window boxes seeds which are easily grown indoors in the winter. They set slips of geraniums and begonias. In the spring they plant vegetables in the outdoor garden, choosing from the previous year's list any they wish to continue, and potatoes, corn, carrots, or asparagus. They take charge of the garden of perennials, renewing, adding to, and tending them.
7. Trips are taken to the sand dunes, the lake shore near the German building in Jackson Park, the Field Museum, Lincoln Park, and a typical swamp.
8. An ant tray is set up containing eggs, larvae, cocoons, and adults. This has a glass top so that the work in the nest may be watched. (For details see Hodge, *Nature Study and Life*, p. 418.)
9. The "Outdoor Book" is continued. Volume II contains records of the new material studied in the grade.

To the first-grade list of outdoor things are added:

Trees and Shrubs	Weeds	Wild Flowers	Animals
Carolina poplar	Pigweed	Spring beauty	Aphid
Silver-leafed poplar	Peppergrass	Buttercup	Soldier beetle

Trees and Shrubs	Weeds	Wild Flowers	Animals
Ash	Mullein	Wake-robin	Oak gall
Box elder	Bittersweet	Spiderwort	Goldenrod gall
Linden	Shepherd's purse	Bloodroot	Leaf miners
Forsythia	Cocklebur	Solomon's seal	Cutworm
Weigelia			Tree hopper
Sumac			Borers
			Tomato worm

10. Laboratory

Preparation of cocoa, grape jelly, baked apple, apple sauce, ice-cream, roasted nuts, baked potato, broiled bacon.

11. Mineral collection

A trip is taken to the lake shore to collect stones and start individual collections. Children make heavy cardboard boxes to hold sixteen small boxes for specimens of the following:

Limestone	Slag	Greenstone
Marble	Milky quartz	Mica
Coral	Flint	Coal
Slate	Chert	Conglomerate
Shale	Sandstone	
Shells	Granite	

12. Weather chart

A record of temperature is kept only when its relation to our garden, the animals, or the children's play gives it genuine significance. The pupils establish experimentally the freezing-point and boiling-point of water. They note the temperature at which our thermostat is set.

13. A toy menagerie is made after a visit to the Lincoln Park zoo. These animals and their environment are further studied through pictures, descriptions, and stories.

14. Seed collection

This is made by gathering seeds on the various trips, classifying them as to means of distribution, and putting away for spring planting any which we wish to perpetuate.

GRADE III

In the third grade a more definite organization of data is made, scientific problems growing out of the central activities are worked out in more detail, and the quantitative element is considered to some extent.

OUTLINE OF MATERIALS AND ACTIVITIES

1. Care of pets

The beehive in some years is the special care of the third grade. Through reading-slips and other printed matter and by first-hand observation the children learn some fundamentals of the care of bees, and it is their duty to instruct children of the other primary grades at certain morning exercise periods so that all may be intelligent regarding the beehives.

2. Swallowtail and monarch butterflies and luna moths are studied

3. Aquarium

The new aquarium stocked by the second grade is passed on to the third grade. In the fall newts and salamanders are the new centers of interest. The following spring a trip to a swamp is made to get crawfish, water striders, may-fly and damsel-fly larvae and to renew acquaintance with material found the previous year. These give experience with swamp life under fall as well as spring conditions.

4. Recognition and study of the following birds: catbird, fox sparrow, nut-hatch, kinglet, downy woodpecker, bobolink, and rail. Nesting habits of birds. Building of bird houses. Feeding birds in winter.

5. Indoor and outdoor garden

The garden work in this grade constitutes the basis of most of the science work. The group is responsible for the currant bushes and the raising of bulbs. The children plant tulips, daffodils, hyacinths, and narcissus in quantities out of doors. For indoor planting they choose scilla, freesia, cyclamen, or oxalis. Each child owns a pot of one of these and takes it home when in bloom.

The children make a map of the whole garden, in which they show the plats and the shrubs and perennials. Seeds for children's individual gardens are chosen from the following list: sensitive plant, bachelor's button, daisy, portulaca, squash, cucumber, cauliflower, cabbage, tomato.

Planting and care of shrubs which provide food for birds.

6. Field trips may be taken to give experiences in lake-shore, swamp, and dune areas. The trips of previous grades may be repeated.

7. Hibernation of animals is watched through the making of an outdoor cage for toads, turtles, frogs, and snails. The information thus gained is extended and enlarged through reading about the hibernation of these and other animals. In this connection a wild-animal scrapbook is made.

8. The "Outdoor Book" of the first and second grades changes its form but not its purpose in this grade. Here specimens of trees, shrubs, weeds, and wild flowers are added to the individual records. These are pressed and mounted under thin celluloid to keep them intact, and are placed in the museum as a means of identification for the use of children of the other grades.

The particular list of nature material which is added in this grade for identification and familiarity is as follows:

Trees and Shrubs	Weeds	Wild Flowers	Animals
Sycamore	Ragweed	Columbine	Land snails
Birch	Lamb's quarters	Crowfoot violet	Spider
Mulberry	Heal all	Dutchman's-	Beetle
Horse chestnut	Wild parsley	breeches	
Catalpa	Cinquefoil	Wild geranium	
Locust	Catnip	Shooting star	
Wild cherry		Wintergreen	
Bridal wreath		Bearberry	
Barberry			
Flowering currant			

9. Laboratory

The children dry apples and grapes. In this connection some definite work in the study of evaporation is begun.

10. The mineral collection begun in the second grade is continued and enlarged here. Quartzite, iron pyrites, galena crystals, iron, silver, gold, hornblende, and mica schist are added. Such of these as cannot be found locally may be purchased from Ward's Natural Science Establishment, 84-102 College Ave., Rochester, N.Y., or Kreg, Sheerer & Co., 404 West 27th St., New York.

This grade makes rock candy for Christmas, using large quantities to secure big, perfect crystals. The children make small crystals of salt, sugar, and alum, coloring them with iron rust, copper, and other mineral coloring-matter. They visit the Field Museum to see the crystal collection.

11. The weather record in the third grade is continued on the same general plan as in the second, and during our very cold weather a chart is kept showing comparative temperatures, one in the far north, another in the far south, and the third in Chicago. Data for the first two are obtained from the daily papers. Some experiments in evaporation and condensation and in expansion and contraction of materials under heat variation are tried.
12. The wild-animal study continued from the second grade is noted in paragraph 7 above.
13. Tree-planting in the garden is taken up. With this activity goes the care of the vines to see that they are replaced and added to as necessity demands.

[To be continued]